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ABSTRACT

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When proficiency testing is undertaken to estimate the effectiveness of job performance, assessment of both knowledge and skill is often required. If job sample tests are used in such assessment, they provide for the measurement of both knowledge and skill since they are based upon samples of the actual performance required in a job. If job knowledge tests are used, only knowledge can be assessed since such tests are based upon an analysis, extraction, and sampling of the information required in job performance. They cannot be used to measure skill. Nevertheless practical constraints can be expected to promote the use of paper and pencil knowledge tests alone since they are simple and economical to administer. It is desirable therefore to determine where knowledge tests can reasonably be substituted for job sample tests.

HumRRO research done under Work Unit UTILITY, which compared the job proficiency of men at different ability levels and with different amounts of job experience, provided an opportunity to examine the relationship between job sample test scores and job knowledge test scores in four Army jobs. These jobs, covering a fairly broad range of job types and task complexity, were Armor Crewman, Vehicle Repairman, Supply Specialist, and Cook. The Armor Crewman job consists principally of sequences of interaction between a man and a weapon system with most tasks being largely procedural. The Repairman is a maintenance job involving adjustment, trouble-shooting and replacement and repair tasks. The Supply Specialist

job is clerical, calling primarily for coordination and recording of information. The Cook job calls for preparation of food in accordance with a master menu and detailed recipes. Recognition of standards and precision in meeting them are primary characteristics of this job.

Representative tasks in each of these jobs were analyzed and the extent to which skilled behavior is required in the performance of individual task steps was identified. This analysis and the empirical relationships between job sample test scores and job knowledge test scores supported the proposition that job knowledge tests are valid for measuring proficiency in jobs where: 1) skill components are minimal, and 2) job knowledge tests are carefully constructed to measure only that information which is directly relevant for performing that job.

Method

Job sample tests and conventional multiple choice knowledge tests were administered to a total of approximately 370 men in each of the four jobs. In the construction of job knowledge tests particular attention was given to include only information which was clearly relevant to job performance. Each job sample test was individually administered and took from three and one-half to five hours to complete. Each job sample test was comprised of a number of subtests. To make testing realistic and to simulate job conditions, each subtest consisted of the performance of a single entire task with a natural beginning and ending. Tasks were composed of a series of steps that would ordinarily be performed as part of a single opera ion in the performance of a job.

Subtest tasks or problems were introduced to subjects just as they might ordinarily encounter them. For example, on one of the Repairman subtests, a tank had been prepared so that the oil seals

leaked and the subject was told that oil was being thrown out of the tank's grill doors. The Repairman was to locate the source of the oil leak and repair the malfunction. In this problem there were 19 necessary steps. As an example, the first nine steps were: 1) ~~testee~~ subject removes a fan vane by removing four screws securing vane to housing, 2) removes cotter pin, slotted hex nut, and flat washer, securing fan assembly to fan drive shaft, 3) removes fan assembly from shaft, 4) reports fan tower seals leaking, 5) cuts and removes locking wire from bolts in oil seal housing, 6) removes six capscrews securing housing, 7) screws two 5/16-18 X 4 bolts in threaded holes in oil seal housing, 8) turns both bolts in evenly until oil seal housing separates from fan drive housing cover, and 9) removes bolts from oil seal housing.

The Armor Crewman's job performance was assessed on 20 subtests with a total of 354 steps to be performed and scored, the Repairman on 13 subtests with a total of 175 steps, the Supply Specialist on 8 subtests with 156 steps, and the Cook on 5 subtests with 158 steps.

As mentioned earlier, the behavior required in performing each step in each of the subtests was analyzed and categorized according to whether it was judged to be mediated by knowledge alone, a combination of cognitive skill and knowledge, or some combination of perceptual and motor skill and knowledge.

To carry out the categorization of each step job knowledge was considered to be information about material used on the job and about acts, procedures, and principles needed to mediate job performance. If it was judged that the steps could be performed on the basis of information alone, it was categorized as requiring knowledge only.

Job skill refers to a rather heterogeneous grouping of abilities. These abilities are inferred on the basis of behavior that is not

completely mediated by knowledge or verbalization of a to-be-performed act. The acquisition of skill, being able to do something rather than knowing what to do, unlike the acquisition of knowledge, requires practice or rehearsal. Indeed, the need for practice in its development can be considered a major definitional characteristic of a skill. This characteristic is particularly important for it provides a convenient basis for deciding whether or not skill is being manifested in any given behavior.

A related and common, though probably not essential, characteristic of skill is that skilled behavior is typically not completely specifiable by verbal means even though the ends of such behavior are. For example, a person cannot be told by verbal instruction how to recognize subtle shadings in pitch in auditory tones or in a spoken language or how to swing a baseball bat. These behaviors can be demonstrated but cannot be completely reduced to verbal description largely because the mechanisms underlying them are internal and non-verbal (auditory processes in the case of discriminating tones, kinesthetic processes in swinging a bat) and language generally does not provide commonly agreed upon verbal labels for describing such processes.

Four main classes of job skill can be identified: perceptual skills, motor skills, cognitive skills, and social skills. While for some purposes it may be useful to distinguish additional varieties of skill, for example, artistic skills, these four classes seem to cover the critical varieties of skill in most jobs. If a step was judged to require some form of practice, it was categorized according to one of these three classes of skill. None of the steps in any of the performance tests required social skill.

Results

Analysis of the behavior required in each task step revealed that the skill requirements in these jobs were minimal. Table 1 shows the number of steps in each job sample test judged to be mediated by knowledge alone and those judged to acquire cognitive skill or some combination of perceptual and motor skill. ~~None of the steps in any of the performance tests required social skill~~.

Insert Table 1 about here

Skill requirements in the Supply Specialist job are virtually non-existent.

This analysis suggests that the correlation between job sample test scores and job knowledge test scores in each of these jobs would be high and that in all likelihood the correlation would be highest in the Supply Specialist job.

The (zero order) correlations between the job sample test scores and the job knowledge test scores are given in Table 2.

Insert Table 2 about here

Reliabilities for the job knowledge tests were: Armor Crewman - .81, Repairman - .76, Supply Specialist - .92, and Cook - .84. Only estimates of the lower limits of job sample test reliabilities could be obtained. The correlations given in Table 2 are substantial, if the job knowledge reliabilities are taken as the maximum possible value of test validity. These correlations, then, tend to support our proposition that job knowledge tests can be appropriately substituted for job sample tests when a

job contains little or no skill components and when only knowledge required on the job is included in the knowledge test. During the analysis of the job sample test step requirements, the skill components in the four jobs were judged to be minimal. Even in the Repairman and Cook jobs, where manual operations and the use of tools are common, skill requirements appeared to be small. It may be assumed that most persons are able to perform in either of these jobs almost completely on the basis of knowledge both of the required tasks and of the specific operations entailed. As anticipated the highest correlation occurred between job sample and job knowledge criteria in the Supply Specialist job. This relationship is of particular significance for this analysis. A clerk's job, typified by the Supply Specialist, represents one of the purest examples of a job where knowledge rather than skill is sufficient to support performance.

Given the high costs associated with job sample criterion testing, not only <u>will</u> job knowledge tests be used, but they <u>should</u> be used where skill requirements in a job are minimal.

Footnote

1. The research reported in this paper was performed at HumRRO Division No. 3, Monterey, California, under Department of the Army contract with the Human Resources Research Organization; the contents of this paper do not necessarily reflect official opinions of policies of the Department of the Army. Reproduction in whole or in part is permitted for any purpose of the Department of the Army.

Table 1

Frequency of Steps in Job Sample Tests Categorized According to Knowledge and Skill Requirements

	Armor	Repair	Supply	Cook
Knowledge alone	338	165	153	145
Cognitive skill and knowledge	0	4	3	11
Perceptual-Motor skill and knowledge	16	6	0	2
Total No. of Steps	354	175	156	158

Table 2

Zero Order Correlations Between Job Sample and Job Knowledge Test Scores[a]

Armor (N=368)	.68
Repair (N=360)	.59
Supply (N=380)	.72
Cook (N=366)	.58

[a]All correlations are significantly different from zero ($p<.05$).